Claims

[c1] 1. A method for controlling the manufacture of a spray-formed tool, comprising:

applying a metallic spray-forming material upon a mold substrate in the manufacture of a spray-formed tool;

detecting temperatures during application of the spray-forming material for at least one position on an exposed surface of the spray-formed tool;

performing a one dimensional simulation that is predictive of characteristics of the spray-formed tool based on the detected temperatures; and

controlling subsequent application of the spray-forming material based on the predicted characteristics.

[c2] 2. The method of claim 1, wherein detecting the temperatures further comprises detecting temperature continuously for the at least one position on the exposed surface of the spray-formed tool.

[c3] 3. The method of claim 2, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation for a column that is a vertical section of the spray-formed tool from the at least one position on the exposed surface of the spray-formed tool down to an interface with the mold substrate.

[c4] 4. The method of claim 1, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation that is predictive of characteristics of a column that is a vertical section of the spray-formed tool from the at least one position on the exposed surface of the spray-formed tool down to an interface with the mold substrate.

[c5] 5. The method of claim 4, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation with a computing device using a one dimensional modeling technique.

[c6] 6. The method of claim 5, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation using the one dimensional modeling technique based on an assumption that heat flows only

up and down along the column that is the vertical section of the spray-formed tool and is radiated off straight upward or conducted straight downward into the substrate mold.

[c7] 7. The method of claim 6, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation using the one dimensional modeling technique to predict phase transformations and residual stresses occurring within the spray-formed tool.

[c8] 8. The method of claim 7, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation using the one dimensional modeling technique to solve a heat equation at every incident time during the application of the spray forming material.

[c9] 9. The method of claim 8, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation using the one dimensional modeling technique to compute temperatures everywhere on the vertical section of the spray-formed tool as a function of time.

[c10] 10. The method of claim 14, wherein performing the one dimensional simulation further comprises predicting the phase transformations and thermal stresses within the spray formed tool based on the computed temperatures as the function of time.

[c11] 11. The method of claim 1, wherein detecting the temperatures further comprises detecting temperature continuously for each of a plurality of representative positions on the exposed surface of the spray-formed tool during application of the spray-forming material.

[c12] 12. The method of claim 11, wherein detecting the temperature continuously for each of the plurality of representative points further comprises selecting the plurality of representative positions strategically to surface irregularities of the spray-formed tool.

[c13]

13. The method of claim 11, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation for a

plurality of columns that are vertical sections of the spray-formed tool from respective ones of the plurality of representative positions on the exposed surface of the spray-formed tool down to respective interfaces with the mold substrate.

[c14] 14. The method of claim 13, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation for the plurality of columns that are predictive of characteristics of each of the plurality of columns.

[c15] 15. The method of claim 1, wherein detecting the temperature further comprises detecting the temperature continuously during application of the spray-forming material with a pyrometer.

[c16] 16. The method of claim 1, wherein performing the one dimensional simulation further comprises performing the one dimensional simulation iteratively at predetermined times during the application of the spray forming material.

[c17] 17. The method of claim 16, wherein controlling the subsequent application of the spray-forming material further comprises periodically reprogramming robotic controls for application of the spray-forming material based on each iteration of the one dimensional simulation.

[c18] 18. The method of claim 1, wherein controlling the subsequent application of the spray-forming material further comprises integrating the one dimensional simulation with robotic controls for application of the spray-forming material.

[c19] 19. The method of claim 18, wherein controlling the subsequent application further comprises altering heat energy input in the application of the spray-forming material by the robotic controls based on the predicted characteristics.

[c20] 20. The method of claim 19, wherein controlling the subsequent application of the spray-forming material further comprises altering heat energy input in the application of the spray-forming material by the robotic controls to control phase transformations and thermal stresses within the spray-formed tool based on the predicted characteristics.